



# Preemption at Broad and Ennis Streets in Fuquay-Varina

NCDOT Traffic Engineering Conference

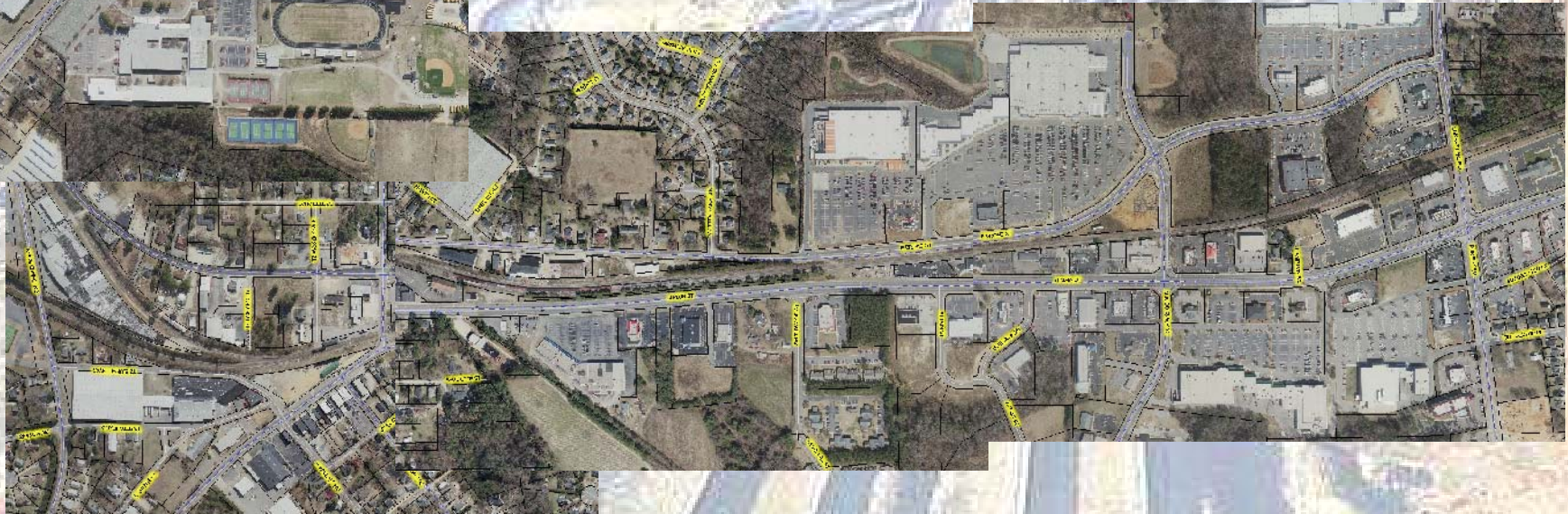
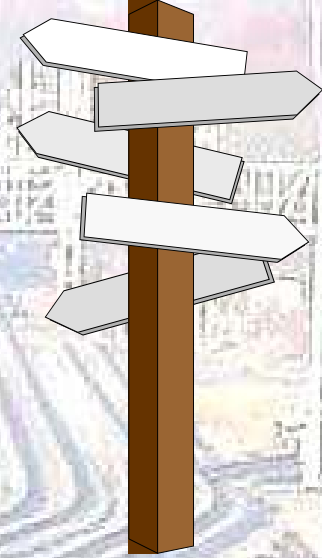
Wilmington, NC

August 23-25, 2006

Rob Ziemba, PE

S&G Railroad and Special Projects Engineer

# Aerial Overview



*“The Crossroads of Fuquay-Varina”*



# Issues

- 2 Intersections Located 500 Feet Apart
- Active Railroad Track adjacent to Broad St.  
Try to keep tracks clear
- Heavy weave/merge/turn area
- Many businesses on Broad Street
- Wake Chapel Road closed for construction
- US 401 (Main Street) - main thoroughfare
- Mainline NC 55 turns along Ennis Street
- Balance thru traffic with local traffic



# Issues



*This is what we seek to avoid:  
Vehicles queuing on the tracks.*



# “Existing” Conditions

- Intersection of Main and Ennis is signalized (6 phase w/protected lefts and leading P/P left on SB Ennis).
- Ennis Street is STOP controlled at Broad Street (Single lane).
- Single WB lane (no turn lane) on Broad St.
- Traffic will queue and fill up “throat” of Ennis St. -> Cars queue on tracks.
- No Existing Track Clearance/Preemption.



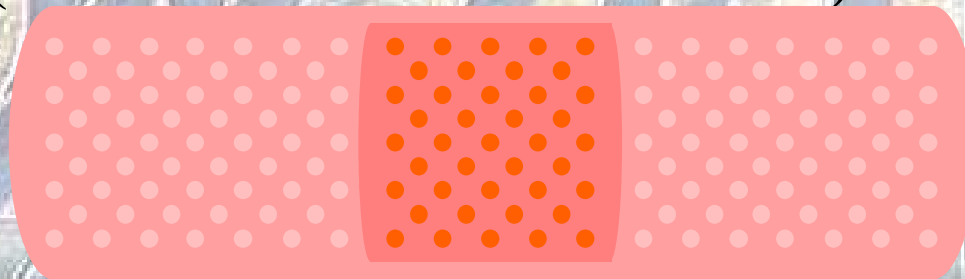
# ”Existing Conditions”





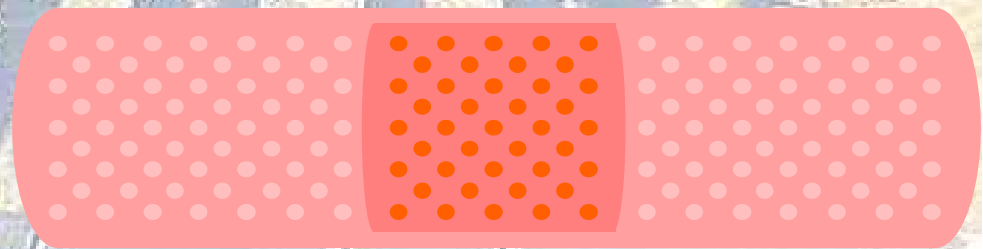
# Initial Changes

- Install signal at Broad and Ennis using existing geometrics. Design Ennis Street to be “main street” (phase 6) with a right turn overlap for EB Broad Street (phase 2). Also provide protected (P/P) phase for WB lefts.
- Signal will have RR Preemption, but run independently from signal at US 401 and Ennis (Time-Base Coordinated).



# Initial Changes

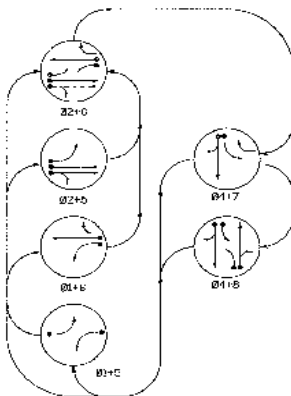
- Revise signal at US 401 (Main Street) to protected/permitted lefts.
- Add queue detectors on SB Ennis near RR Tracks to detect when throat is full.
- Don't want to preempt US 401 signal, so Broad Street signal will be preempted to reduce additional turns onto Ennis Street.



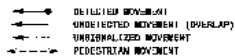


# Initial Changes

PHASING DIAGRAM

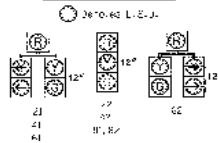


PHASING DIAGRAM DETECTION LEGEND



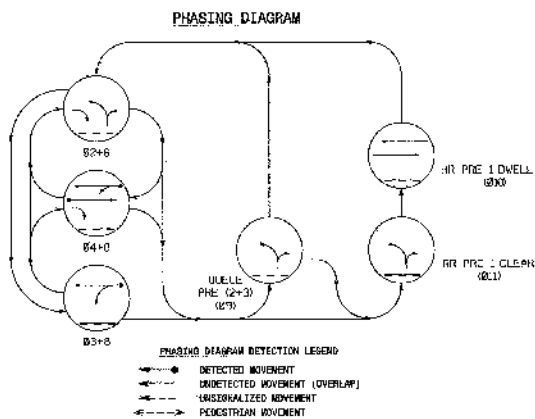
SIGNAL	PHASE						
	1	2	3	4	5	6	7
1	Y	Y	Y	Y	Y	Y	Y
2	Y	Y	Y	Y	Y	Y	Y
3	Y	Y	Y	Y	Y	Y	Y
4	Y	Y	Y	Y	Y	Y	Y
5	Y	Y	Y	Y	Y	Y	Y
6	Y	Y	Y	Y	Y	Y	Y
7	Y	Y	Y	Y	Y	Y	Y

SIGNAL FACE I.D.



2070L LOOP & DETECTOR INSTALLATION									
INDUCTIVE LOOPS					DETECTOR PROGRAMMING				
LOOP	SIZE (FT)	TYPE	DETAILED DRAWING (SHEET)	NO. OF LANE	LOC	SIZE (FT)	TYPE	DETAILED DRAWING (SHEET)	NO. OF LANE
1A	6X60	2-4-2	0	Y	1	Y	Y	Y	Y
2A, 30	6X60	2-4-2	0	Y	2	Y	Y	Y	Y
3A	6X60	2-4-2	0	Y	3	Y	Y	Y	Y
4A	6X60	2-4-2	0	Y	4	Y	Y	Y	Y
5A	6X60	2-4-2	0	Y	5	Y	Y	Y	Y
6A	6X60	2-4-2	0	Y	6	Y	Y	Y	Y
7A	6X60	2-4-2	0	Y	7	Y	Y	Y	Y
8A	6X60	2-4-2	0	Y	8	Y	Y	Y	Y
9A	6X60	2-4-2	0	Y	9	Y	Y	Y	Y
10A	6X60	2-4-2	0	Y	10	Y	Y	Y	Y
11A	6X60	2-4-2	0	Y	11	Y	Y	Y	Y
12A	6X60	2-4-2	0	Y	12	Y	Y	Y	Y
13A	6X60	2-4-2	0	Y	13	Y	Y	Y	Y
14A	6X60	2-4-2	0	Y	14	Y	Y	Y	Y
15A	6X60	2-4-2	0	Y	15	Y	Y	Y	Y
16A	6X60	2-4-2	0	Y	16	Y	Y	Y	Y
17A	6X60	2-4-2	0	Y	17	Y	Y	Y	Y
18A	6X60	2-4-2	0	Y	18	Y	Y	Y	Y
19A	6X60	2-4-2	0	Y	19	Y	Y	Y	Y
20A	6X60	2-4-2	0	Y	20	Y	Y	Y	Y
21A	6X60	2-4-2	0	Y	21	Y	Y	Y	Y
22A	6X60	2-4-2	0	Y	22	Y	Y	Y	Y
23A	6X60	2-4-2	0	Y	23	Y	Y	Y	Y
24A	6X60	2-4-2	0	Y	24	Y	Y	Y	Y
25A	6X60	2-4-2	0	Y	25	Y	Y	Y	Y
26A	6X60	2-4-2	0	Y	26	Y	Y	Y	Y
27A	6X60	2-4-2	0	Y	27	Y	Y	Y	Y
28A	6X60	2-4-2	0	Y	28	Y	Y	Y	Y
29A	6X60	2-4-2	0	Y	29	Y	Y	Y	Y
30A	6X60	2-4-2	0	Y	30	Y	Y	Y	Y
31A	6X60	2-4-2	0	Y	31	Y	Y	Y	Y
32A	6X60	2-4-2	0	Y	32	Y	Y	Y	Y
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34A	6X60	2-4-2	0	Y	34	Y	Y	Y	Y
35A	6X60	2-4-2	0	Y	35	Y	Y	Y	Y
36A	6X60	2-4-2	0	Y	36	Y	Y	Y	Y
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38A	6X60	2-4-2	0	Y	38	Y	Y	Y	Y
39A	6X60	2-4-2	0	Y	39	Y	Y	Y	Y
40A	6X60	2-4-2	0	Y	40	Y	Y	Y	Y
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164A	6X60	2-4-2	0	Y	164	Y	Y</		

# Initial Changes

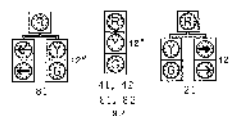


SIGNAL FACE	PHASE							
	1 2 3 4 5 6	7 8 9 10 11 12	13 14 15 16 17 18	19 20 21 22 23 24	25 26 27 28 29 30	31 32 33 34 35 36	37 38 39 40 41 42	43 44 45 46 47 48
1	R	G	G	H	H	G	R	
41, 42	R	G	G	R	G	G		
51, 52	G	G	R	G	G	R		
61	H	G	G	H	R	G		
62	H	G	G	H	R	G		
51, 6	OFF	OFF	OFF	OFF	ON	ON		
51, 6	OFF	OFF	OFF	OFF	ON	ON		

#504 Name: 2

SIGNAL FACE I.D

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2070 RAIL PREEMPTION		
Interval 1 - Transit Clearance Green		1%
Interval 1 - Transit Clearance Yellow		3.5%
Interval 1 - Transit Clearance Red		7.0%
Interval 2 - Transit Clearance		25%
Interval 2 - Transit Yellow		5.0%
Interval 2 - Transit Red		1.3%
Interval 3 - Transit Green		1%
Interval 3 - Transit Yellow		0.5%
Interval 3 - Transit Red		0.5%
Delay Time		0
Min Green Before Pre		-
Post Green Before Pre		5
Yellow Clear Before Pre		0.3 s
Red Clear Before Pre		0.5 s
Post-Emt Time		1
Pre-Clear Through Yellow		5

<sup>4</sup> Decrease time defaults to three weeks for normal, during normal conditions.

2070L LOOP & DETECTOR INSTALLATION										
INDUCTIVE LOOPS					DETECTOR PROGRAMMING					
LOOP	NOT SET	ALIVE	DURATION FROM SIGNAL TO	LOOP	PHASE	CALIBRATION	BEHIND	BEHIND	DETECT TIME	UNIT
			170			BULL	IN	IN		
2.4	6.642	2.4	5	Y	1	1	1	1	1	15
4.6	6.642	4.6	5	Y	1	1	1	1	1	1
2.1	6.61F	3	5	Y	1	1	1	1	1	5
0.6	6.61F	3	5	Y	1	1	1	1	1	5

\* Locate Zone 1st Loop to be seen w/RR Gate on South Side of Tracks.

411 300 6010 0

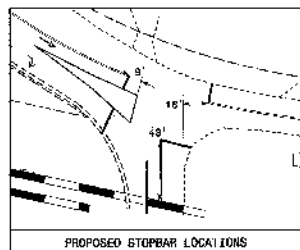
[illegible]

\* Clearance time defaults to times used  
for group driving name/appellation.

3 Phase  
Semi Actuated w/Railroad Preemption  
(Time-Based System)

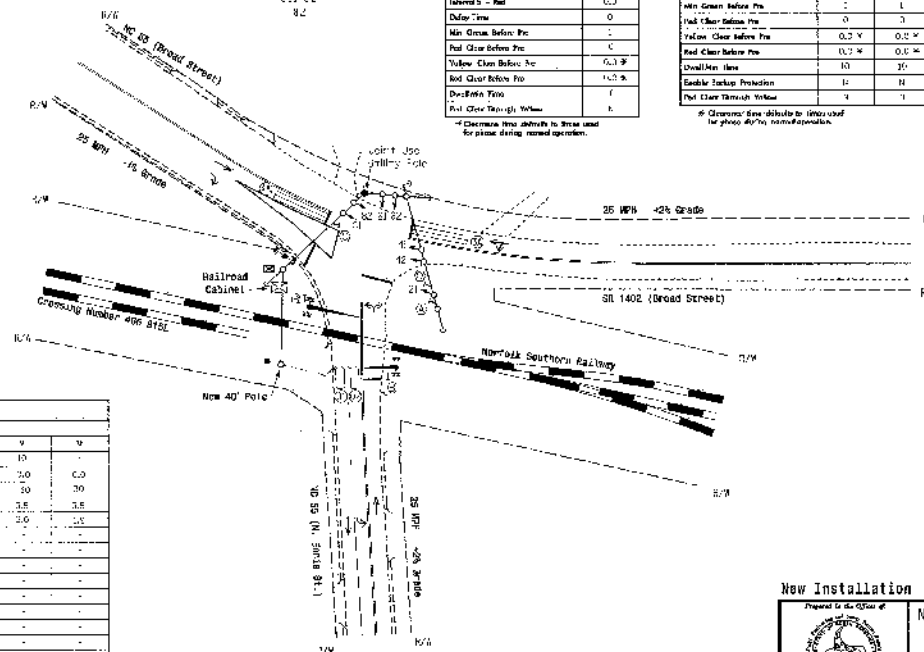
## NOTES

1. Refer to "Roadway Standard Drawings NCDDOT" dated January 2002 and "Standard Specifications for Roads and Structures" dated January 2002.
2. This location contains railroad preemption flashing. Do not program signal for late night flashing operation.
3. Phase 3 may be ignored.
4. Run all "odd-in" coils overhead on existing utility poles where possible.
5. Set all detector units to presence mode.
6. Locate new cabinet so as not to obstruct sight distances of vehicles turning right on red.
7. Minimum times shown in timing chart are for free run operation only. Coordinated signal system timing values supersede these values.
8. Loops 01 and 02 serve as queue detectors. After 6 seconds of constant activation, the controller shall force off to phase 9 and dwell in phase 9 until the presence of a train or until the time no longer receives steady/constant detection.
9. Finish a flashing operation does not alter operation of blinkout signs.



2070L TIMING CHART							
FEATURE	PHASE						
	2	3	4	6	8	9	10
Attn Green *	0.0	7	---	10	7	10	---
Intercom *	1.0	2.0	2.0	2.0	2.0	2.0	0.0
Main Green 1 *	2.0	1.5	2.5	2.0	2.5	1.0	3.0
Yellow Clearance	3.0	4.5	3.5	3.5	3.5	3.5	3.5
Red Clearance	1.0	1.0	1.0	1.0	1.2	2.0	1.5
WUL *	---	---	---	---	---	---	---
Don't Walk 1	---	---	---	---	---	---	---
Secondary For Activation *	---	---	---	---	---	---	---
Main Statistic Valid *	---	---	---	---	---	---	---
Three Minute Indicators *	---	---	---	---	---	---	---
Three To Redden *	---	---	---	---	---	---	---
Minimum Gap	---	---	---	---	---	---	---
Insert Mode	MAX RECALL	---	---	MAX RECALL	---	---	---
Variable Call Memory	---	---	---	---	---	---	---
Small Entry	---	---	SM	---	CH	---	---
Two-Response Unit	CH	CN	0.4	25	29	FM	1.4

\* These volume may be field adjusted. Do not adjust Min Green and saturation times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.



LEGEND

PROPOSED		EXISTING
	Traffic Signal Head	
	Modified Signal Head	N/A
	Sign	
	Pedestrian Signal Head	
	Narrow Push Button	
	Signal Pole with Bay	
	Signal Pole with Bay	
	Industrial Load Device	
	Controller and Cabinet	
	Junction Box	
	2 in. Underground Conduit	
N/A	Light of Way	
N/A	Directional Arrow	
N/A	Bar Trued Gate or Flasher	
N/A	Railroad Tracks	
	"NO TURN ON RED" Sign (R10-12)	
	"DO NOT STOP ON TRACKERS" Sign (R10-5)	
	"NO LEFT TURN" Sign (R10-11)	
	"A.D. Plankout Sign"	
	"NO LEFT TURN - TRAIN"	
	"NO RIGHT TURN - TRAIN"	

New Installation

### Temporary Design



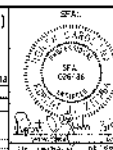
NC 55 / SR 1402 (Broad Street  
at  
NC 55 (Ennis Street))

Divisjon 5      Måke Coasty      Fugloy-Vaizim

FILE DATE:	APRIL 2006	FILE NO.:
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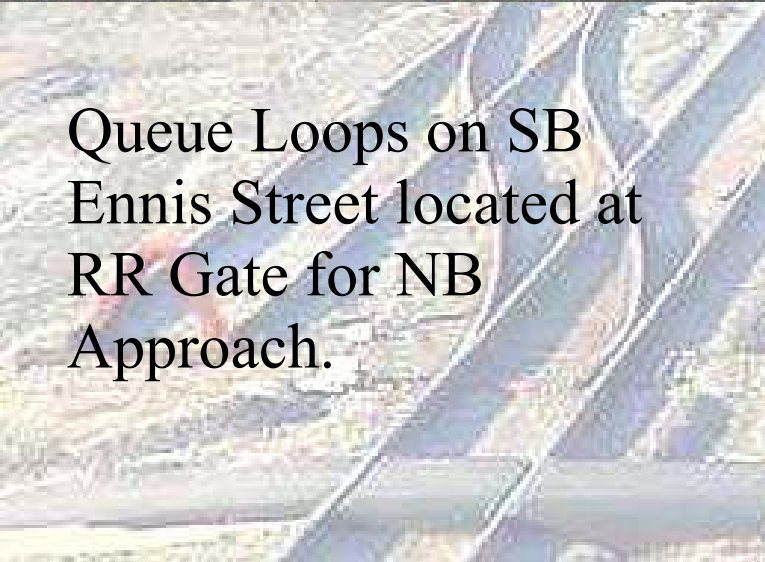
NAME	ADDRESS	CITY	STATE	ZIP
JOHN D. SMITH	12345 MAIN ST.	NEW YORK	NY	10001

10	11	12
13	14	15
16	17	18
19	20	21
22	23	24
25	26	27
28	29	30
31	32	33
34	35	36
37	38	39
40	41	42
43	44	45
46	47	48
49	50	51
52	53	54
55	56	57
58	59	60
61	62	63
64	65	66
67	68	69
70	71	72
73	74	75
76	77	78
79	80	81
82	83	84
85	86	87
88	89	90
91	92	93
94	95	96
97	98	99
100	101	102
103	104	105
106	107	108
109	110	111
112	113	114
115	116	117
118	119	120
121	122	123
124	125	126
127	128	129
130	131	132
133	134	135
136	137	138
139	140	141
142	143	144
145	146	147
148	149	150
151	152	153
154	155	156
157	158	159
160	161	162
163	164	165
166	167	168
169	170	171
172	173	174
175	176	177
178	179	180
181	182	183
184	185	186
187	188	189
190	191	192
193	194	195
196	197	198
199	200	201
202	203	204
205	206	207
208	209	210
211	212	213
214	215	216
217	218	219
220	221	222
223	224	225
226	227	228
229	230	231
232	233	234
235	236	237
238	239	240
241	242	243
244	245	246
247	248	249
250	251	252
253	254	255
256	257	258
259	260	261
262	263	264
265	266	267
268	269	270
271	272	273
274	275	276
277	278	279
280	281	282
283	284	285
286	287	288
289	290	291
292	293	294
295	296	297
298	299	300
301	302	303
304	305	306
307	308	309
310	311	312
313	314	315
316	317	318
319	320	321
322	323	324
325	326	327
328	329	330
331	332	333
334	335	336
337	338	339
340	341	342
343	344	345
346	347	348
349	350	351
352	353	354
355	356	357
358	359	360
361	362	363
364	365	366
367	368	369
370	371	372
373	374	375
376	377	378





# Initial Changes - Queue Loops



Queue Loops on SB  
Ennis Street located at  
RR Gate for NB  
Approach.





# “Back to the Future”

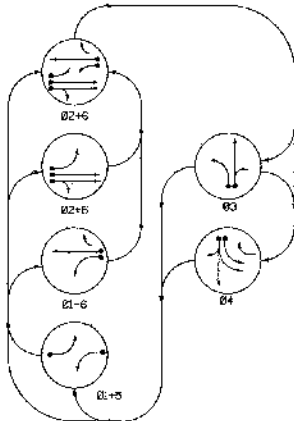
Once Wake Chapel Road Bridge was completed and reopened to traffic:

- Revised SB Ennis St. to include a “Chicken Foot.” Lanes were a left only and a left-thru-right combination lane at US 401 (Main Street).
- Split phase Ennis Street at Main Street signal(minimal NB traffic).

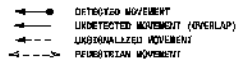


# “Back to the Future”

PHASING DIAGRAM

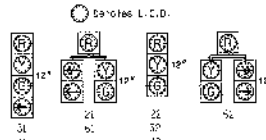


PHASING DIAGRAM DETECTION LEGEND



SIGNAL	PHASE					
	01	02	03	04	05	06
01	R	R	G	R	R	Y
02	H	R	G	H	R	Y
03	R	R	R	G	R	Y
04	R	R	R	G	R	Y
05	R	R	R	G	R	Y
06	R	R	R	G	R	Y

SIGNAL FACE I.D.

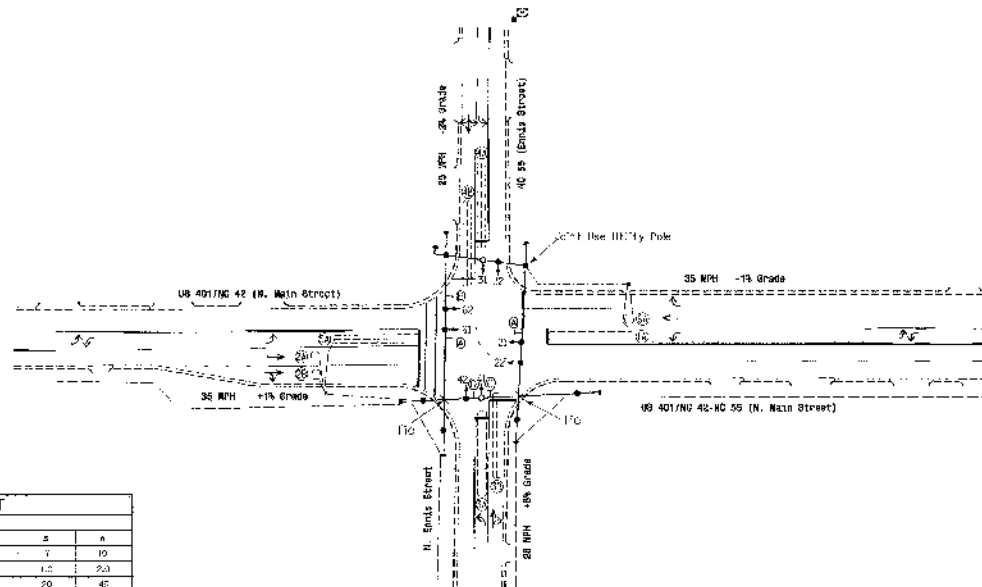


INDUCTIVE LOOPS				DETECTOR PROGRAMMING			
LOOP	SIZE	TYPE	STATUS	PHASE	EXTENSION	EXTENSION	EXTENSION
15	200	EXISTING	0	1	Y	Y	15
22, 26	200	EXISTING	0	2	Y	Y	22
5A	200	EXISTING	0	3	Y	Y	5A
2B	200	EXISTING	0	4	Y	Y	2B
24	200	EXISTING	0	5	Y	Y	24
7	200	EXISTING	0	6	Y	Y	7
5A	200	EXISTING	0	3	Y	Y	5A
6A	200	EXISTING	0	4	Y	Y	6A

## 8 Phase Fully Actuated (Time-Based System)

### NOTES

- Refer to "Roadway Standard Drawings" NCDOT dated January 2002 and "Standard Specifications for Roads and Structures" dated January 2002.
- Do not program signal for late night flashing operation unless otherwise directed by the Engineer.
- Unit phase 1 during phase 2 on.
- Unit phase 5 during phase 6 on.
- Program controller to clear from phase 2+5 to phase 1 and/or 5 by progressing through phase 4 (see Electrical details for wiring).
- The order of phase 3 and phase 4 may be reversed.
- Set all Detector Units to presence mode.
- Reposition existing signal head number 42.
- Reposition existing signal head 82 as 32.
- Reposition existing loops 8A as 3A and 8B as 3B.
- Maximum times shown in timing chart are for free-run operation only. Coordinated signal system timing values supersede these values.
- Stopbar locations are existing.
- Existing "Left Turn Yield on Green" sign (R10-12) may be removed at the discretion of the Regional Traffic Engineer.



2070L TIMING CHART

FEATURE	PHASE					
	1	2	3	4	5	6
Max Green 1"	15	15	15	15	15	15
Max Green 1"	15	25	25	15	15	25
Max Green 1"	15	45	45	25	25	45
Yellow Clearance	3.5	3.5	3.5	3.5	3.5	3.5
Red Clearance	2.5	2.5	2.5	2.5	2.5	2.5
Walk 1"	-	-	-	-	-	-
Don't Walk 1"	-	-	-	-	-	-
Interval for Pedestrian *	-	-	-	-	-	-
Max Vehicle Interval *	-	-	-	-	-	-
Time Before Redout *	-	-	-	-	-	-
Time To Advance *	-	-	-	-	-	-
Minimum Gap	-	-	-	-	-	-
Round Mode	15th Street	15th Street	15th Street	15th Street	15th Street	15th Street
Vehicle Call Memory	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
Dual Entry	-	-	-	-	-	-
Separation Gap	0.1	0.1	0.1	0.1	0.1	0.1

\* These values may be field adjusted. Do not adjust Max Green and Greenout times for phases 2 and 4 from 15 seconds unless shown. All Green for all phases should not be less than 4 seconds.

PROPOSED	LEGEND	EXISTING
○	Traffic Signal Head	○
●	Modified Signal Head	●
+	Sign	+
+	Pedestrian Signal Head	+
+	15th Push Button & Sign	+
+	Signal Pole with Bay	+
+	Signal Pole with Sidewalk Bay	+
+	Inductive Loop Detector	+
+	Controller & Cabinet	+
+	Junction Box	+
+	2-in Under ground Conduit	+
+	Right of Way	+
+	Bi-directional Arrow	+
+	Left Turn Yield on Green Sign (R10-12)	+
+	Right Arrow "ONLY" Sign (R3-5R)	+
+	Left Arrow "ONLY" Sign (R3-5L)	+
+	Dual turn end through Arrow Sign	+

## Signal Upgrade

		US 401/NC 42-55 (N. Main St.) at NC 55 (N. Ennis St.)		SEAL NORTH CAROLINA DEPARTMENT OF TRANSPORTATION DIVISION 5 DATE: 05/14/05 BY: [Signature] PROJECT NO.: 05-0185
Division 5 DATE: 05/14/05 BY: [Signature]		Project No.: 05-0185 Project Name: US 401/NC 42-55 (N. Main St.) at NC 55 (N. Ennis St.) Project Location: [Location] Project Description: [Description]		Project No.: 05-0185 Project Name: US 401/NC 42-55 (N. Main St.) at NC 55 (N. Ennis St.) Project Location: [Location] Project Description: [Description]



# “After Further Review”

During Initial RR Preemption Inspection when signal was first turned on, it was decided some changes were needed to improve operation:





## “After Further Review”

- Remove static “NO TURN ON RED” sign (R10-11) --> Saying No Turn on Red and then displaying a Red Ball with a Green (Right Turn) Arrow was confusing motorists.
- Add “NO TURN ON RED” LED Blankout sign to illuminate when Red Ball is on without Green Arrow (During WB Protected Left or during any preempt phase).



# “After Further Review”

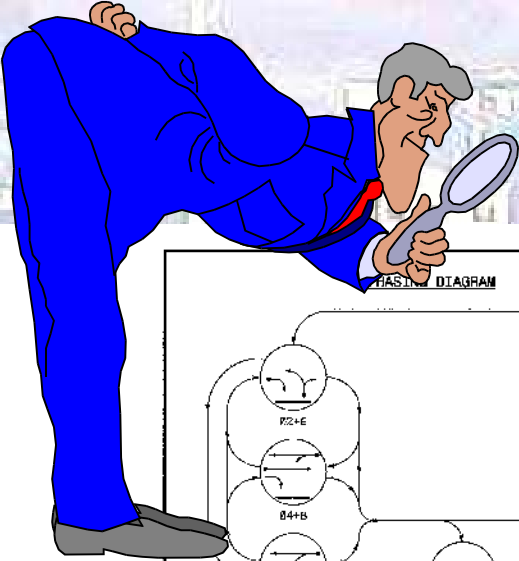


Top: EB displays during Phase 3  
(WB Protected Left)



Left: LED Blankout sign in  
Operation





# "After Further Review"

PHASE DIAGRAM

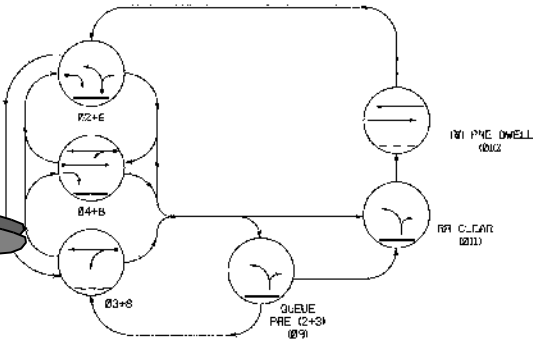
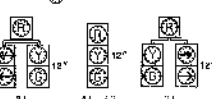


TABLE OF OPERATION											
SIGNAL	FACE	PHASE									
		1	2	3	4	5	6	7	8	9	10
21		R	C	R	C	R	C	R	C	R	C
41, 42		R	C	R	C	R	C	R	C	R	C
61, 62		R	C	R	C	R	C	R	C	R	C
81		R	C	R	C	R	C	R	C	R	C
82		R	C	R	C	R	C	R	C	R	C
101, 102		R	C	R	C	R	C	R	C	R	C
121, 122		R	C	R	C	R	C	R	C	R	C

SIGNAL FACE I.D.

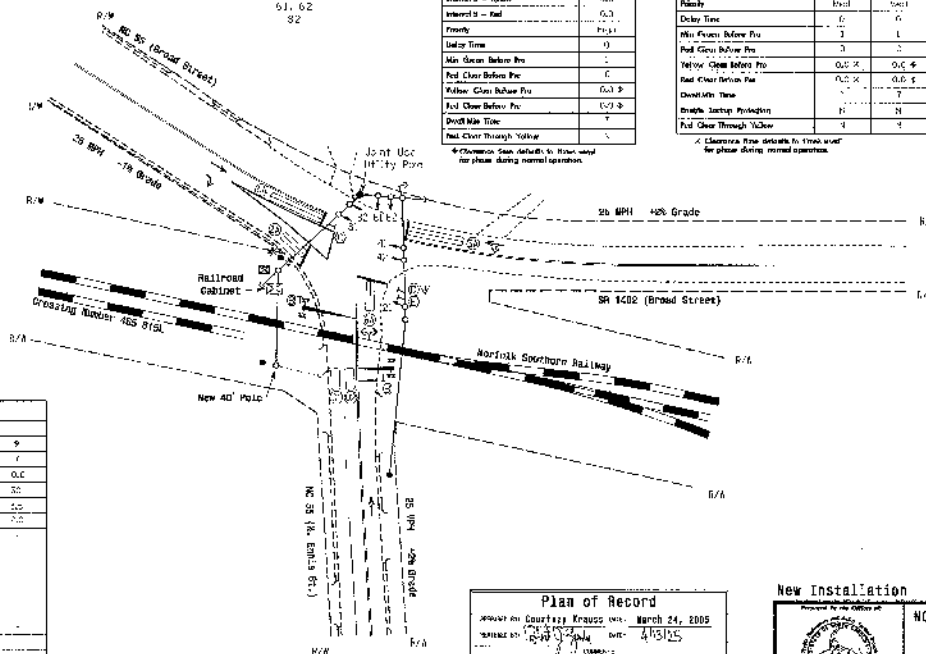
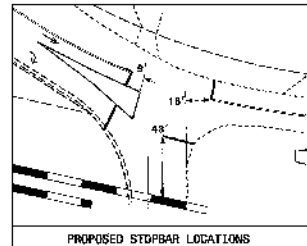


2070L LOOP & DETECTOR INSTALLATION											
LOOP	SIZE	TYPE	PHASE	INDUCTIVE LOOP	DETECTOR	PHASE	INDUCTIVE LOOP	DETECTOR	PHASE	INDUCTIVE LOOP	DETECTOR
21	5220	2-1-1	1	2	2	2	2	2	2	2	2
31	5220	2-1-1	1	2	2	2	2	2	2	2	2
41	5220	2-1-1	1	2	2	2	2	2	2	2	2
51	5220	2-1-1	1	2	2	2	2	2	2	2	2
61	5220	2-1-1	1	2	2	2	2	2	2	2	2
71	5220	2-1-1	1	2	2	2	2	2	2	2	2
81	5220	2-1-1	1	2	2	2	2	2	2	2	2
91	5220	2-1-1	1	2	2	2	2	2	2	2	2
101	5220	2-1-1	1	2	2	2	2	2	2	2	2
111	5220	2-1-1	1	2	2	2	2	2	2	2	2
121	5220	2-1-1	1	2	2	2	2	2	2	2	2

## 3 Phase Fully Actuated w/Railroad Preemption (Time-Based System)

### NOTES

- Refer to "Roadway Standard Drawings" dated January 2002 and "Standard Specifications for Roads and Structures" dated January 2002.
- This location contains railroad preemption phasing. Do not program signal for late night flashing operation.
- Phase 3 may be lagged.
- Run all lead-in cable overhead on existing utility poles where possible.
- Set all detector units to presence mode.
- Locate new cabinet so as not to obstruct sight distance of vehicles turning right on red.
- Maximum times shown in timing chart are for free run operation only. Boarded signal system timing values supersede these values.
- Loops Q1 and Q2 serve as queue detectors. After 5 seconds of constant activation, the controller shall force off to phase 9 and dwell in phase 9 until the presence of a train or until the loop no longer receives steady/constant detection.
- Ensure flashing operation does not alter operation of blankout sign.
- Remove existing "NO TURN ON RED" sign - (R10-11).
- Illuminate Sign (C) at the beginning of the preceding red clearance interval. This sign will remain illuminated until the beginning of the succeeding green phase.



2070L TIMING CHART									
FEATURE	PHASE								
	2	3	4	4	5	6	7	8	9
Min. Green 1 *	10	7	7	10	7	7	10	7	7
Extension 1 *	0.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Max. Green 1 *	30	25	25	30	25	25	30	25	25
Yellow Clearance	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Red Clearance	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Walk 1 *	-	-	-	-	-	-	-	-	-
Don't Walk 1	-	-	-	-	-	-	-	-	-
Severely Flashed *	-	-	-	-	-	-	-	-	-
Max. Variable Yellow *	-	-	-	-	-	-	-	-	-
Time To Green *	-	-	-	-	-	-	-	-	-
Withstand Cap.	-	-	-	-	-	-	-	-	-
Signal Mode	MTM 1000	-	-	MTM 1000	-	-	MTM 1000	-	-
Vehicle Call Memory	-	-	-	-	-	-	-	-	-
Shall Entry	-	-	-	-	-	-	-	-	-
Street/Through Cap.	CH	CH	CH	CH	CH	CH	CH	CH	CH

\* These values may be left unprogrammed, but not programmed with Green and Extension times for phases 2 and 8 lower than what is shown. Min. Green for all other phases should not be lower than 6 seconds.

**Plan of Record**

APPROVED BY: [Signature] DATE: March 24, 2009

DESIGNED BY: [Signature] DATE: 3/15/09

REVIEWED BY: [Signature] DATE: 3/15/09

REVISIONS: [Table with revision details]

**New Installation Temporary Design**

NC 55 / SR 1402 (Broad Street) at NC 55 (Ennis Street)

DESIGNED BY: [Signature] DATE: March 2009

REVIEWED BY: [Signature] DATE: March 2009

APPROVED BY: [Signature] DATE: March 2009

PROJECT NO: [Number] REVISION NO: [Number]

SCALE: 1"=40'

DATE: 3/15/09

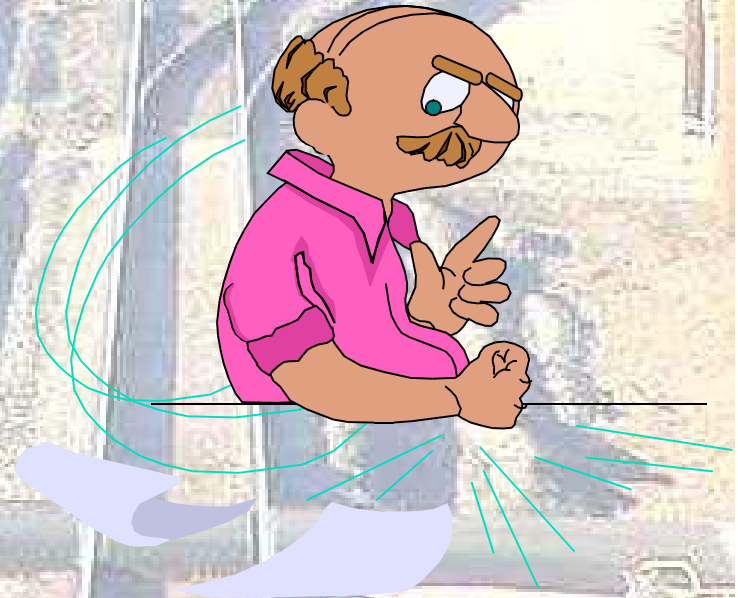
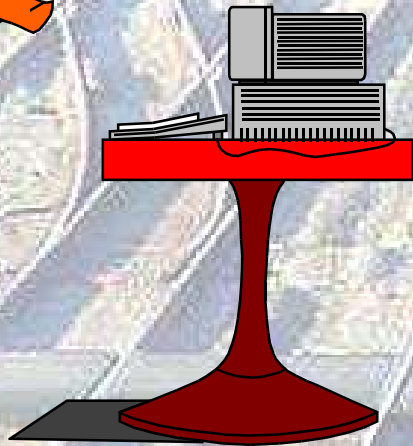
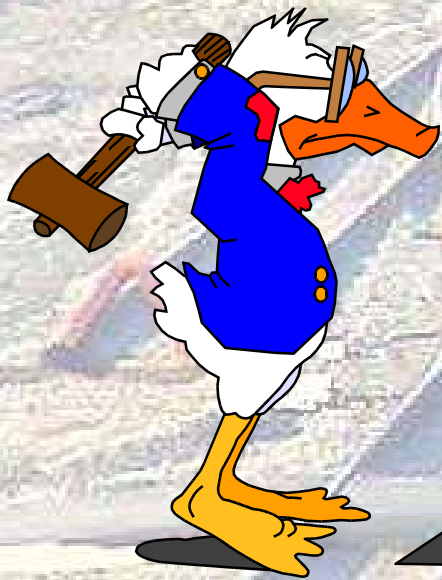
BY: [Signature]

FOR: [Signature]

# So, How Does It Work?



- Queue Detection actually worked so well (in terms of detection and preemption), Division had to disconnect queue loops to avoid Queue Preemption.
- Reports of 2 mile queues on Broad Street.
- Numerous complaint calls to Division.



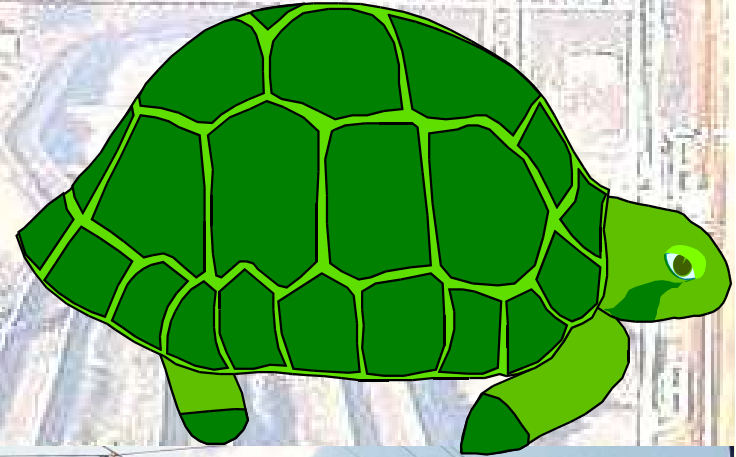
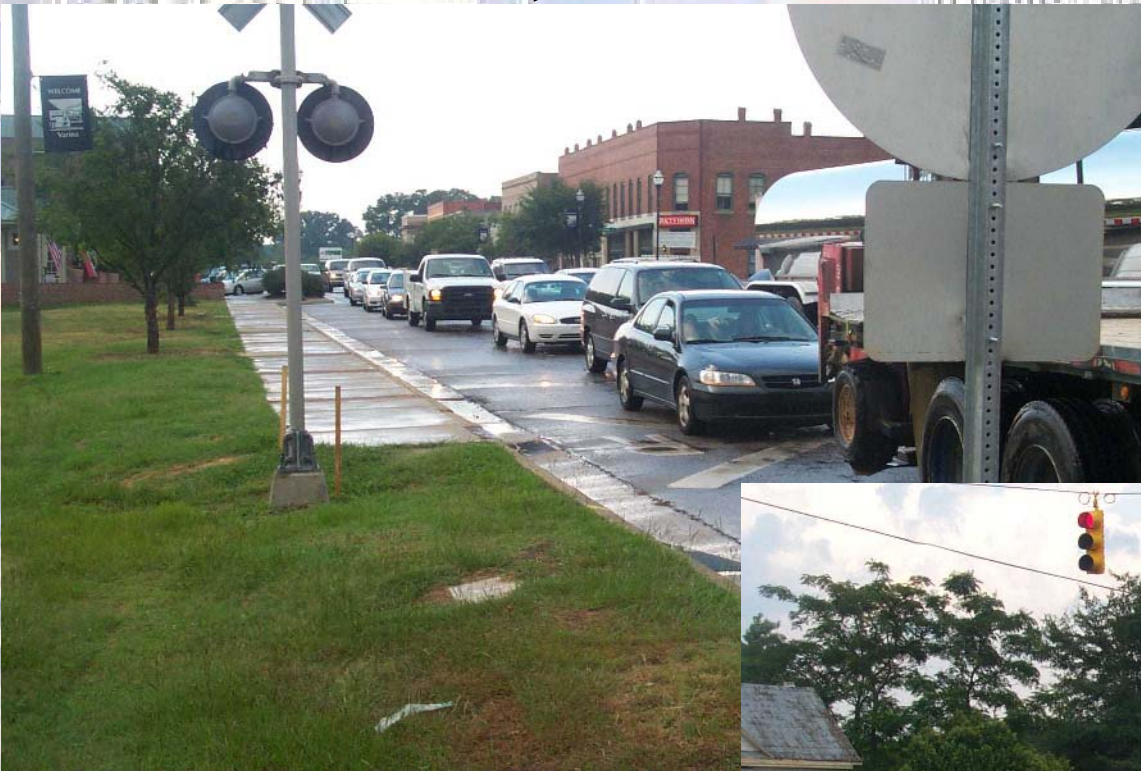


# So, How Does It Work?



*EB Broad Street during RR Preempt.*

# So, How Does It Work?



*Traffic queues along  
both directions of Broad  
Street.*





# So, How Does It Work?



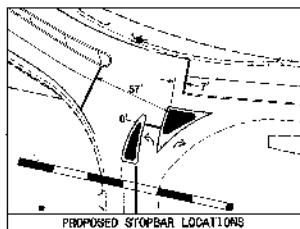
*SB Ennis St queuing up for signal at US 401. Notice no vehicles are using right “chicken foot” lane to turn left. Maybe due to construction cones?*



# What's On Deck?

- Widen Broad Street to include WB left turn lane.
- Flare out Ennis Street after tracks to provide a NB right turn yield movement.
- Add islands on Ennis Street.
- Additional changes on Ennis Street being done as part of a Developer Project for new CVS on NW corner of Ennis and Main Street.



$$q = 4 - 4\sqrt{2} \approx -2.657, \quad \text{and} \quad \log_{10} \left( \frac{1}{1 - 2\sqrt{2}} \right) \approx 0.222, \quad \text{and} \quad \log_{10} \left( \frac{1}{1 - 2\sqrt{2}} \right) \approx 0.222, \quad \text{and} \quad \log_{10} \left( \frac{1}{1 - 2\sqrt{2}} \right) \approx 0.222.$$


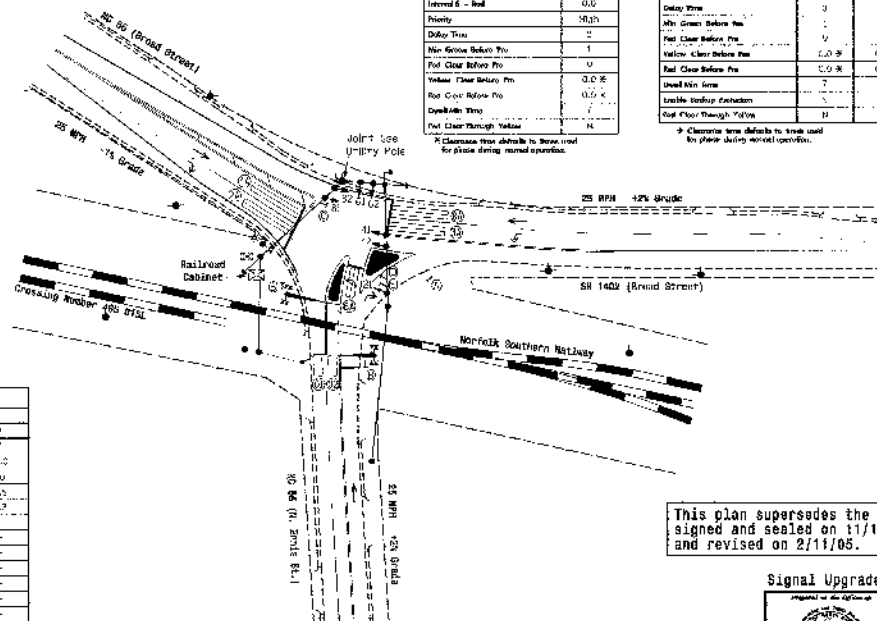
\* Clearance from electrical to Series 1100 for piping design, material purchasing.

→ Electronic time defaults to time used in other parts of the construction.

7. Maximum times shown in timing chart are for free-run operation only. Coordinated signal system timing values supersede these values.
8. Locate all underground utilities prior to pole drilling and conduit trenching.
9. Loops Q1 and Q2 serve as queue detectors. After 5 seconds of constant actuation, the controller shall force off to phase 9 and call in phase 9 until the presence of a train or until the loop no longer resolves steady/constant detection.
10. Ensure flashing operation does not occur operation of blinkout sign.
11. Illuminate sign Q1 at the beginning of the preceeding red clearance interval. This sign will remain illuminated until the beginning of the succeeding green phase.

PHOTOCEN	LEGEND	EXISTING
	Traffic Signal Head	N/A
	Modified Signal Head	-
	Pushout from Signal Head	-
	Signal Pole with Sign	-
	Signal Pole with Traffic Bay	-
	Inductive Loop Detector	-
	Cabinet	-
	Junction Box	-
	2-in. Underground Conduit	-
	Right of Way	-
	North Arrow	-
	Railroad Gate and Fender	-
	Railroad Crossing	-
	"YIELD" Sign (R1-2)	(C)
	"DO NOT STOP ON REDUCES" Sign (S1-3)	(C)
	"ONE LEFT TURN - YIELD" Sign (E.C.B. Standard)	(C)
	"ONE LEFT TURN ON RED" Sign (E.C.B. Standard)	(C)
	"ONE LEFT TURN SIGNAL" Sign (R10-102)	(C)

<sup>b</sup> These values may be field estimated. Do not request Min Green and Extreme Green for phases 2 and 3; leave them blank to allow Min Green for all other phases should not be lower than 4 percent.



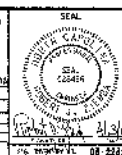
This plan supersedes the plan signed and sealed on 11/18/04 and revised on 2/11/05.

Signal Upgrade

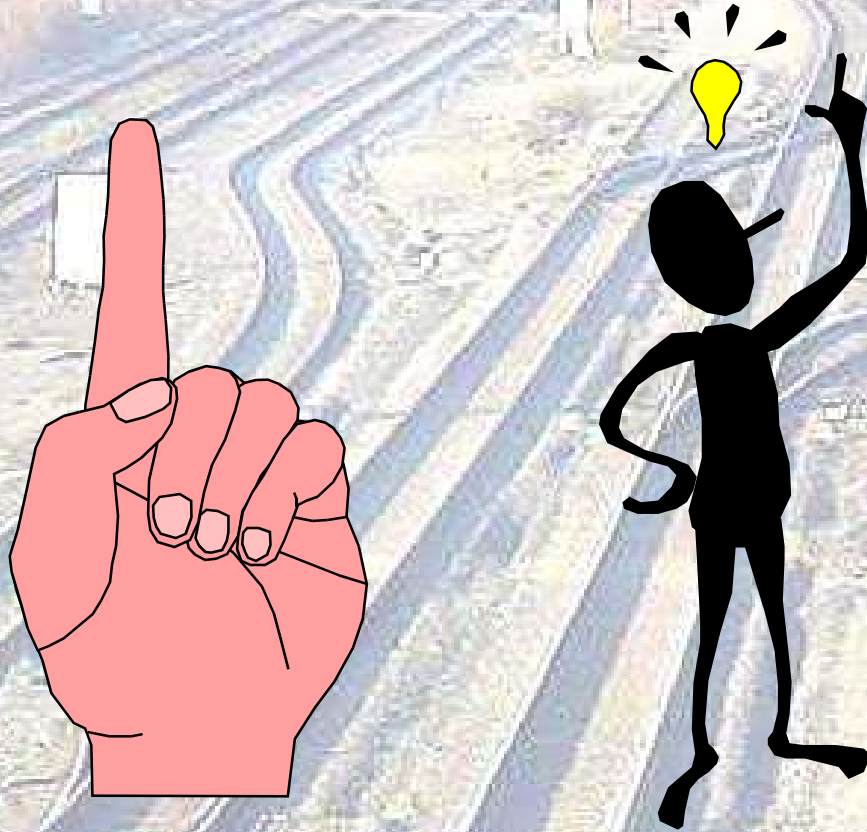
### Final Design



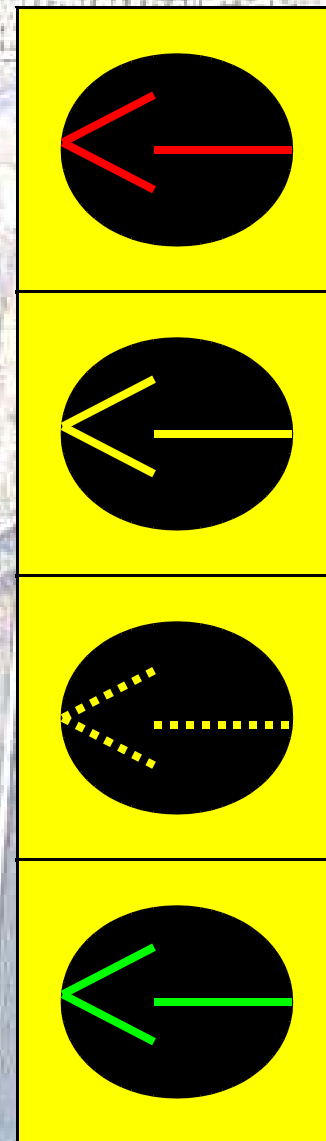
MC 55 / SR 1402 (Broad Street) at MC 55 (Ennis Street)	
Division 5	Main Street Sagay-Winifred
Date: March 2005	Prepared by:
Drawn by: C. Krauss	Reviewed by:



“But Wait, There’s a  
Better Way....”

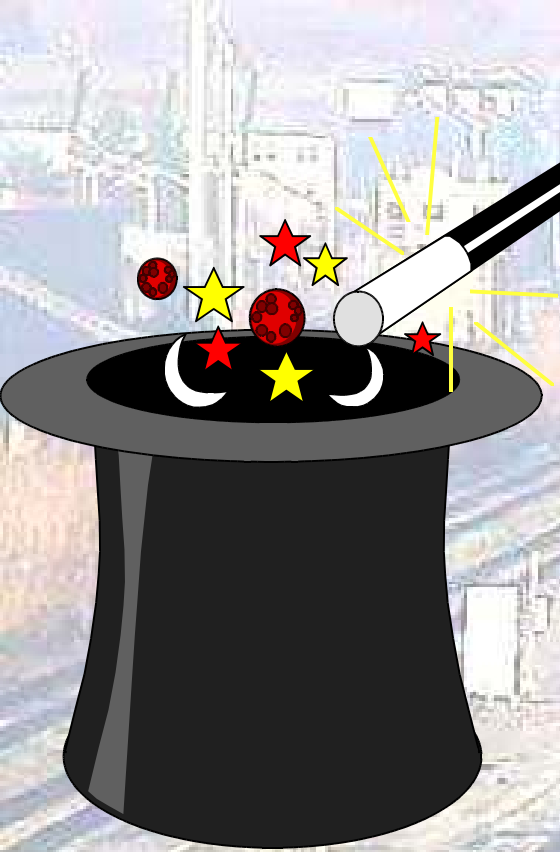


# 4 Section Flashing Yellow Arrow





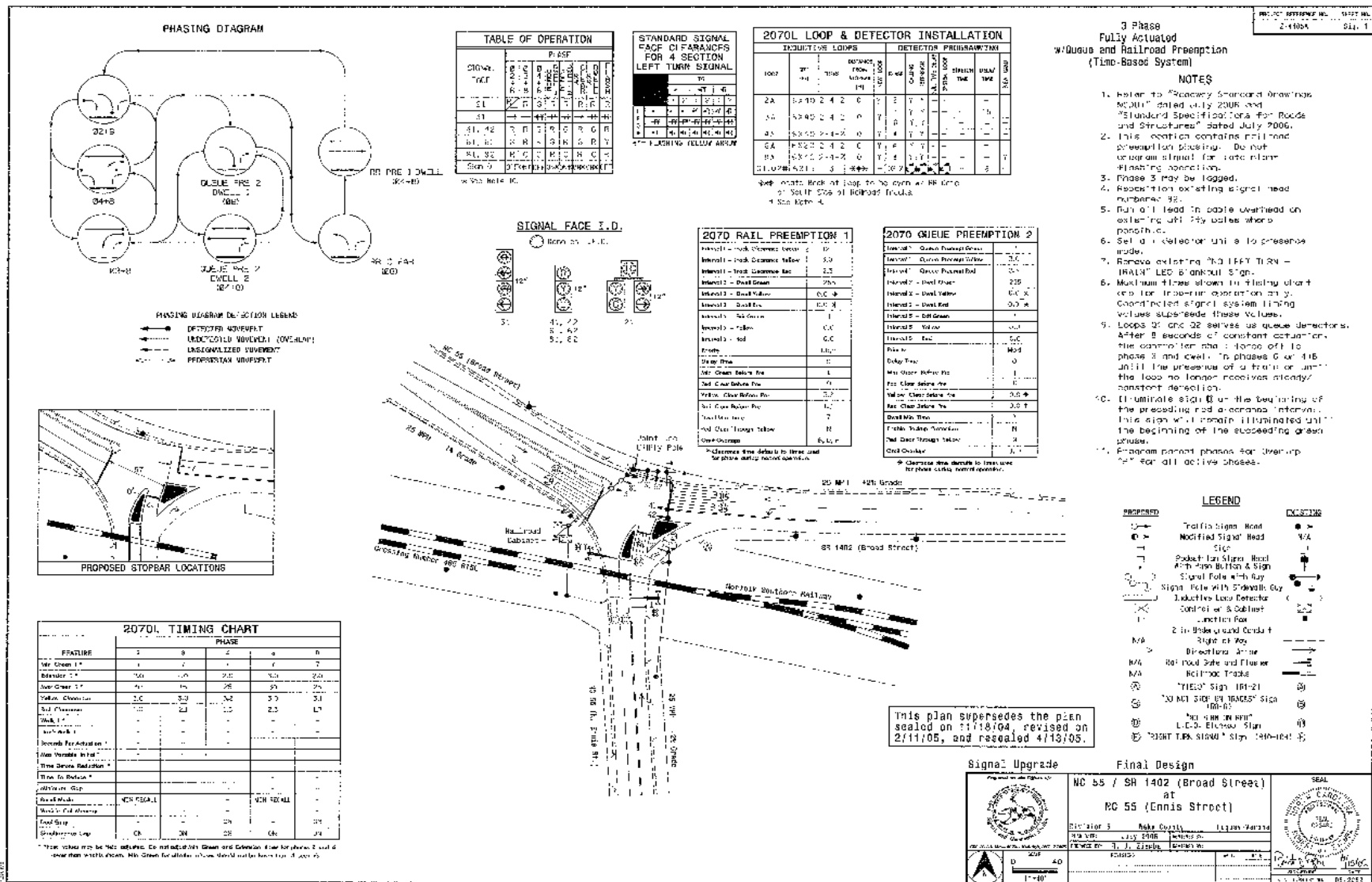
# Benefits of Using the 4 Section Flashing Yellow Arrow Signal Head

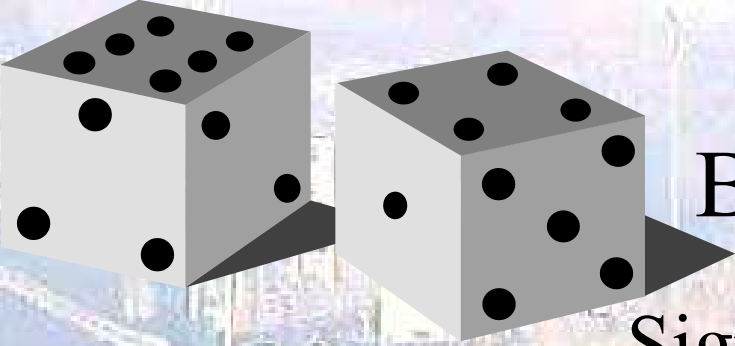


- Revise signal to add second Queue Preempt Phase allowing through traffic on Broad Street to continue, but prohibit turns.
- Can remove WB Blankout sign --> RED Arrow will prohibit left turns during preempt while through traffic still has Green.

# What's On Deck?

## 4 Section Flashing Yellow Arrow





## But Wait, There's More....

Signal will use ALL RED Flash

- Motorists expect stem of Tee to Stop
- Stopping vehicles on tracks during flashing Red may trap them.
- All RED Flash “creates” a gap (R/W) on intersecting street so vehicle can clear path of train if on tracks (Preempt and track clear are inactive during Flashing Operation.
- Signal should only flash in the event of a malfunction.



## But Wait, There's More....

- Signal will also utilize “Overlap P,” which will run during all normal phases and queue preemption.
- Overlap will terminate when railroad preemption call is received.
- Once overlap is terminated, can begin Track Clearance Green.
- This will ensure that we have a consistent clearance time during RR Preemption (Important that gates be in synch with signal). Eliminates using Phases 9 or 10 for preempts.

Questions??

Phone: (919) 733-5570

Email: [rziemba@dot.state.nc.us](mailto:rziemba@dot.state.nc.us)

